GII OVERVIEW AND THE ROLES OF SATELLITES IN THE GII

(Invited Paper)

Ramon 1 '. 1)e 1 'aula
NASA Headquarters
Washington, DC 20546

1 'olly Estabrook
Jet Propulsion laboratory
Pasadena, CA

ABSTRACT

This presentation will give an overview of the vision for the Globs] Information Infrastructure (GII). The concept of the GII as a worldwide "network of networks" that will create a global information marketplace, encouraging broadbased social discourse within and among all countries, will be presented. The GII is creating an in form ation explosion that is producing ever increasing demands on all communications systems. Satellites will be an essential element of the G]], providing services and capabilities never available before. The presentation will discuss the roles and challenges for satellite systems to operate seamlessly with terrestrial networks and be fully included in the GII.

Overview of the GII

Vice President Al Gore introduced the U.S. vision for the Global information Infrastructure (GII) at the first World Telecomm unications Develop m ent Conference in Buenos Aires, Argentina, in March 1994, with the following words:

> "1 **et us build a global community in which the people of neighboring countries view each other not as potential enemies, but as potential partners, as members of the same family in the vast, increasingly interconnected human family."**

View President Gore called upon every nation to establish an ambitious agenda to build the G]], using the following five: principles as the foundation[1]:

- Encouraging private sector investment;
- Promoting competition;
- Providing open access to the network for all information providers and users;
- Creating a flexible regulatory environment that can keep pace with rapid technological and market changes;
- Ensuring universal service.

The docu ment GII: Agend a for Cooperation[1] amplify these five principles and identify the steps the Unit ed St ates, in concert with other nations, can take to make the vision of the! GII a reality.

The Clinton Administration has made the development of an advanced National Information Infrastructure (NII) and the GII top U.S. priorities. A major goal of the NII is to give U.S. citizens access to a broad range of information and information services. Using innovative telecommunications and information technologies, the NII will help the U.S. achieve a broad

range of economical and social goals. The U.S. is but one of many countries currently pursuing national initiatives to capture the promise of the "Information Revolution." The U.S. initiative share with others an important, common objective: to ensure that the full potential benefits of advances in information and telecommunications technologies are realized for all citizens[1].

The GII is an outgrowth of the NII perspective, a vehicle for expanding the scope of these benefits on a global scale. By interconnecting local, regional, national, and global networks as shown in figure 1, the GII will increase economic growth, create jobs, and improve infrastructures. Taken as a whole, this worldwide "network of networks" will create a global information marketplace, encouraging broad-based social discourse within and among all countries[1].

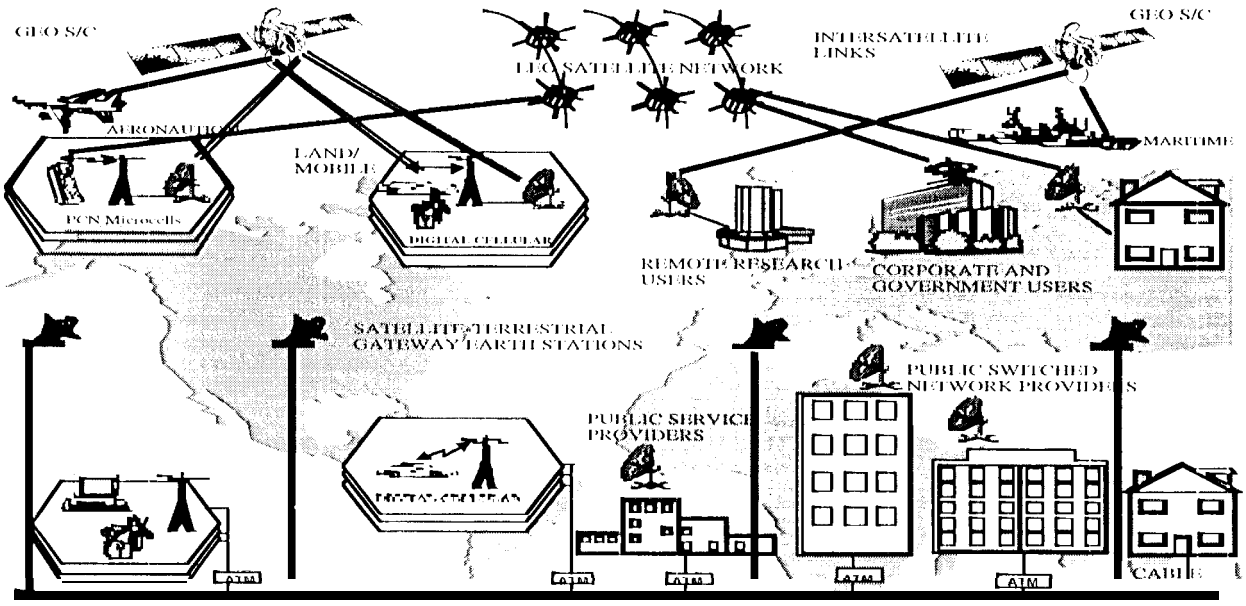

Fig. 1 Vision of the Global Information Infrastructure[2,3]

The GII will depend upon an ever-expanding range of technology and products. This includes: telephones, fax machines, computers, switches, compact discs, video and audio tape, coaxial cable, wire, satellites, optical fiber transmission lines, microwave networks, televisions, scanners, cameras, and printers -- as well as advances in computing, information, and networking technologies not yet envisioned[1].

The vision and principles of the GII were again presented by Vice President Gore during the G-7 Ministerial meeting on the Information Society in Brussels on 25 and 26 February 1995. The vision and principles were strongly endorsed by the G-7 Ministers. They agreed on the need to promote the establishment of global interconnection of national broadband research networks and testbeds to provide basic infrastructure for information society applications. Ten projects were established during this meeting. The Global Interoperability for Broadband Networks (GIBN), one of the ten of the G-7 Information Society projects, will promote the establishment of international links among existing networks of the G-7 countries and others. This will provide an opportunity to develop standards, experiment on interoperability among international networks, and exploit new broadband network applications. The GIBN will be one of the key projects promoting the vision and principles of the GII.

As the GII evolves there is also a change in trends in information services as shown[3]:

TODAY		*TOMORROW*
• Analog/Digital	➡	• Digital/Analog
• Moderate Data Rates	➡	• High Data Rates
• Moderate Channel Capacity	➡	• Very High Channel Capacity
• Wired Systems	➡	• Wireless Systems
• National Networks	➡	• International Networks
• Limited Competition	➡	• Increased Global Competition
• High Prices	➡	• Low Prices
• Limited Availability	➡	• Universal Access
• Independent Services	➡	• Integrated Services
• Moderate Variety of Services	➡	• Much Wider Variety of New Services
• Modest User Expectation for Reliability, Capacity, Privacy, ant] Security	➡	• High User Expectation for . . .

The role of satellites in the GII

The GII will both stimulate: and respond to global demand for new information technologies and services. Future satellite communications systems will be an essential and critical element of the GI 1, They will enable new services that are not otherwise afford able or possible by terrestrial communications systems. They will be interoperable with terrestrial components of the NII and G]]. Satellite systems will be flexible to the user needs, providing bandwidth capacity available: on demand. They will be reconfigurable to met new' and changing requirements, provide switched services to direct interconnect users. A wide variety of satellite systems, designs and functions will fill specific GII roles in a seamless manner[3,4].

Satellite systems as one of the: key elements in the GII will enable new services such as:

- Remote! medical imaging diagnostics,
- Global personal communications,
- l{eal-time voice, video and data transmission to mobile users,
- Advanced fixed ant] wireless business networks,
- Tele-educati on/Dista nce learning to remote areas,
- 1 nterconnection of high data rate networks to remote locations,
- Connection of Supercomp uters

Man y new GEO and LEO satellite systems arc! now being proposed. They will enable the advanced services listed above, and much mom. Some of the systems will start operating as early as 1998. The broadband GEO systems arc: Voice Span, Astrolink, CyberStar, Galaxy/Sp aceway, Millennium, Orion, GE Star, NetSat 28 and few others. The LEO systems are: Iridium, Odyssey, Globalstar, ICO, Ellipso, Teledesic, ant] others.

They will be essential in providing one important aspect of the! (ill: ***"universa l service."*** The goal is to provide access and affordable service to all members of society. Universal service is one of the most important principles of the GII vision. More than 2/3 of the earth's popul ation do not have access to wired terrestrial communications services. First the infrastructure does not exist to support install ation of wired services. Second in today's global market it would be prohibitively expensive to try to provide fiber or wire services to this segment of the population. Satellites' systems of the! types mentioned above will en able all kinds of services to be brought. to this very 1 arge section of the population.

Additionally satellites have! many advantages such as[2,3]:

- Ubiquitous coverage (connectivity to everyone, everywhere)
- Wide area high speed multipoint network
- Cost not distant dependent
- Allows user mobility
- Immune to natural disasters
- Permits simultaneous distribution of information to numerous users
- Enables rapid development and global interconnectivity of at low cost.

Satellites are also the only economical systems that can provide aeronautical and maritime mobile communications services of voice, video and data.

Challenges for satellite systems in the GII

However, satellite systems face several challenges to be successful and competitive in the GII. These challenges are in the areas of government policies and required technologies. The challenges to realizing full potential of satellites in the GII are[5]:

- Spectrum allocation
- Standards and protocols
- Launch vehicle cost
- Hybrid networks seamless interoperability
- Advanced technologies
- International cooperation

To complement a complex global hybrid network system, enable new services, and helps build the GII vision and support its principles, satellites must overcome all of the above challenges. For example, GII requirements exceed allocated spectrum. New and proposed satellite and terrestrial services have dramatically increased demands on currently allocated spectrum. There is extreme competition for spectrum among the many new services in personal and mobile communications, local-multipoint distribution system (LMDS), interactive multimedia, broadcasting and satellites. GEO satellite slots at the traditional C and Ku bands are nearly full worldwide increasing demand for new frequency bands such as the Ka band. Proposed LEO and GEO systems require worldwide allocation of same frequency spectrum.

The success of the GII requires that all communications systems operate seamlessly. This makes interoperabilty one of the critical issues for hybrid network systems. There are inherent intrinsic differences between fiber optic and satellite links in bit error rate(BER), channel capacity and delay as shown in Table 1.

	SATCOM	Fiber
BER	10^{-9} - 10^{-11} (with coding correction)	10^{-12}
Capacity	Up to GBIT (with frequency reuse)	up to TBITS
Delay	250 msec (GEO) 5 - 20 msec (LEO)	up to tens of ms

- **Table 1. intrinsic differences between satellite link versus fiber optic link.**

The differences in communications links require that standards and protocols be designed to function over different types of networks. However, currently some of the more widely used protocols such as TCP/IP or ATM are not very efficient over satellite links and require modifications[4,6]. ATM, for example, was developed for high speed multi-media traffic over fiber optic links. ATM networks expect fiber-like quality from the satellite link. ATM propagation over a satellite link is not very efficient without modifications to the ATM protocol or the satellite link or both[6].

Attention must be given to developing applications, new architectures and technologies, new standards and protocols, that will meet the challenge to work efficiently over different communications links that includes delay, asymmetrical channel capacity, different bit error rates. This new architectures and protocols must at the same time provide efficient seamless integration of satellite and terrestrial networks.

Conclusions

To achieve the full potential of the future GII, concerted efforts and strong partnerships among industry, governments and academia are needed. Since the GII is a global vision, excellent **international cooperation is necessary and critical** for the success of the GII. Satellite and terrestrial services will be equally important to the success and goals of the GII. The G-7 nations, as declared in Brussels in 1995, want to promote faster and more economical deployment of these services to users around the world. Proper spectrum allocation and coordination world-wide by the many different governments are vital to the success of satellite systems and the GII. In many applications and services in the GII, satellites may be one of the important elements, and in other applications satellites may be the most cost effective. New satellite systems will offer added capability in services to support the GII principles of universal services, open access, and promote competition. Finally, most important, **seamless integration** of terrestrial and satellite networks are key to enable the GII vision in a **timely and affordable manner**.

Acknowledgments

The research performed for this paper by Polly Estabrook was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

References

1. The Global Information Infrastructure: Agenda for Cooperation, Document from the U.S. Department of Commerce, 1995. >> http://nii.nist.gov/whatgii.html
2. R.P. De Paula and R. Bonometti, NII/GII Overview,16th AIAA ISCSC Colloquium,Feb. 25, 1996.
3. NASA Workshop, The Role of Communications Satellites in the Information Infrastructure, June 1994, College Park, MD.
4. L. P. Seidman, Role of Satellites in the Global Information Infrastructure, IEEE COMPCON' 95 Conference, March 5-9, 1995.
5. T.A. Brackey, Satellites in the Information Infrastructure: A Partnership for Action, Presentation at Industry/Government Round Table, December 15, 1995, Washington, DC.
6. G.M. Comparetto, Using ATM Over SATCOM Links, Proceedings of the Fourth International Mobile Satellite Conference, pg. 525-532, June 6-8, 1995, Ottawa, Canada.
7. GII WWW Internet Sites: http://www.gii.org./giic/egi00000.html and http://nii.nist.gov/whatgii.html